REPORT DOCUMENTATION PAGE

Form Approved OMB No. 074-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	March 2000	Magazine

4. TITLE AND SUBTITLE
Gateway: Volume XI, Number 1

5. FUNDING NUMBERS
SPO700-98-D-4001

6. AUTHOR(S)
Greg Barbato
Tom Metzler
Rebecca Singer
Alan Newell

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Human Systems IAC
2261 Monahan Way, Bldg. 196
WPAFB, OH 45433-7022

8. PERFORMING ORGANIZATION REPORT NUMBER
GWXI1

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Booz Allen & Hamilton Inc.
4141 Colonel Glenn Highway
Dayton, OH 45431

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.
Free to public by contacting the Human Systems IAC.
Free on internet at http://iac.dtic.mil/hsiac

12b. DISTRIBUTION CODE
A

13. ABSTRACT *(Maximum 200 Words)*

This issue contains articles on the following topics: 1.Uninhabited Combat Air Vehicle Controls and Displays for Suppression of Enemy Air Defenses; 2.The New Director of CSERIAC; 3.Human Systems Integration Technologies, Tools, and Techniques (HSIT3); 4.Designing for Extra-ordinary People and Situations; 5.Leveraging the Technical Area Task (TAT) Program

14. SUBJECT TERMS
Uninhabited Combat Controls Displays Human Systems Disabilities Human Computer Interaction

15. NUMBER OF PAGES
16

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UNLIMITED

Volume XI: Number 1 (2000)

CSERIAC

GATEWAY

Published by the Crew System Ergonomics/Human Systems Technology Information Analysis Center

inside:

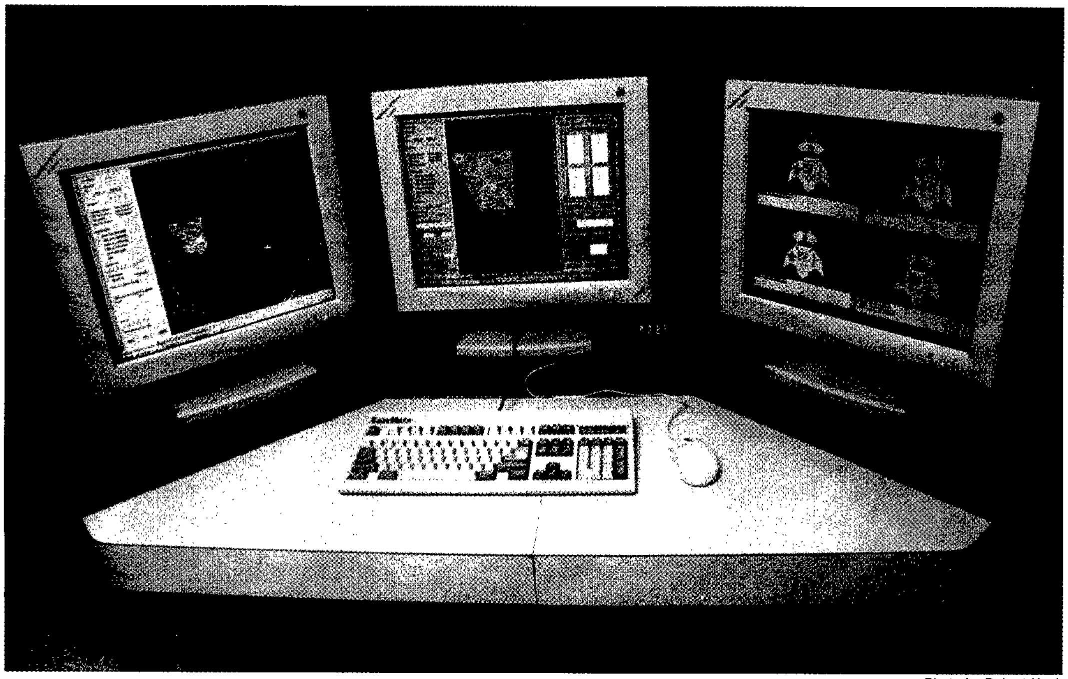


Figure 1. UCAV Operator Vehicle Interface prototype control station.

Photo by Robert Hock

Uninhabited Combat Air Vehicle Controls and Displays for Suppression of Enemy Air Defenses

Greg Barbato

In the Air Force of the future, there will be a mix of inhabited and uninhabited aircraft. The term "uninhabited" is used—rather than "unpiloted" or "unmanned"—to distinguish the new aircraft, enabled by new technologies, from those now in operation. Current unmanned aircraft (cruise missiles or reconnaissance) have particular advantages such as cost or endurance. Uninhabited Combat Air Vehicles (UCAV) will be new, high-performance aircraft that are more effective for particular missions than are their inhabited counterparts.

Removing the pilot from the aircraft saves money, prevents the pilot's being injured or captured, permits faster digital communication, and allows for a smaller radar signature. While there will be missions during the next 20 years that continue to require that a pilot be present, for many missions, uninhabited aircraft will have superior capabilities.

One operational concept receiving much attention within the U.S. Department of Defense and Air Force involves the Suppression of Enemy Air Defenses (SEAD) mission by the year 2015. The SEAD mission neutralizes, destroys, or temporarily degrades surfaced-based enemy air defenses. While the UCAV may be uninhabited, it still requires humans to plan the mission and coordinate with the other services and allied forces.

The Human Effectiveness Directorate of the U.S. Air Force Research Laboratory is beginning a new UCAV

continued on next page

http://iac.dtic.mil/cseriac

CSERIAC is a United States Department of Defense Information Analysis Center, administered by the Defense Technical Information Center (DTIC), Defense Information Systems Agency (DISA), Ft. Belvoir, VA, technically managed by the Air Force Research Laboratory Human Effectiveness Directorate, Wright-Patterson Air Force Base, OH, and operated by Booz·Allen & Hamilton, McLean, VA.

continued from previous page

Operator Vehicle Interface (OVI) program to research issues with the human operator control stations for the UCAV. There are two program objectives. First, quantify UCAV control station requirements for the 2015 SEAD mission to evaluate automatic versus manual function tradeoffs that will enable a single operator to manage multiple UCAVs. Second, design operator-vehicle interfaces that integrate control/display technologies and decision-aiding features so that the system (the operator plus the UCAVs) can successfully accomplish all mission requirements. Since the system exists only as a concept, the research uses a simulated system.

We already know that the UCAV operators' console will be highly automated, and there are critical human factors issues concerning the operator's interaction with that automation. The operator will be responsible for establishing system goals, monitoring and directing automated subsystems, and ensuring the overall success of the mission. However, experience has shown that automation can have both desirable and undesirable effects. While automation can greatly improve the performance by taking over tasks that are performed poorly by a human operator or by reducing operator workload, high levels of automation cause the operator to become a system monitor, a task humans do poorly when they are not in the "decision-making loop." In fact, the term "clumsy automation" is often used to describe automation that is inconsistent or incompatible with the way humans think. With clumsy automation, there often is little or no feedback to the operator regarding system intent or performance. As a result, operators can be surprised by the behavior of an automatic system, which often leads to unanticipated—and sometimes undesirable—outcomes.

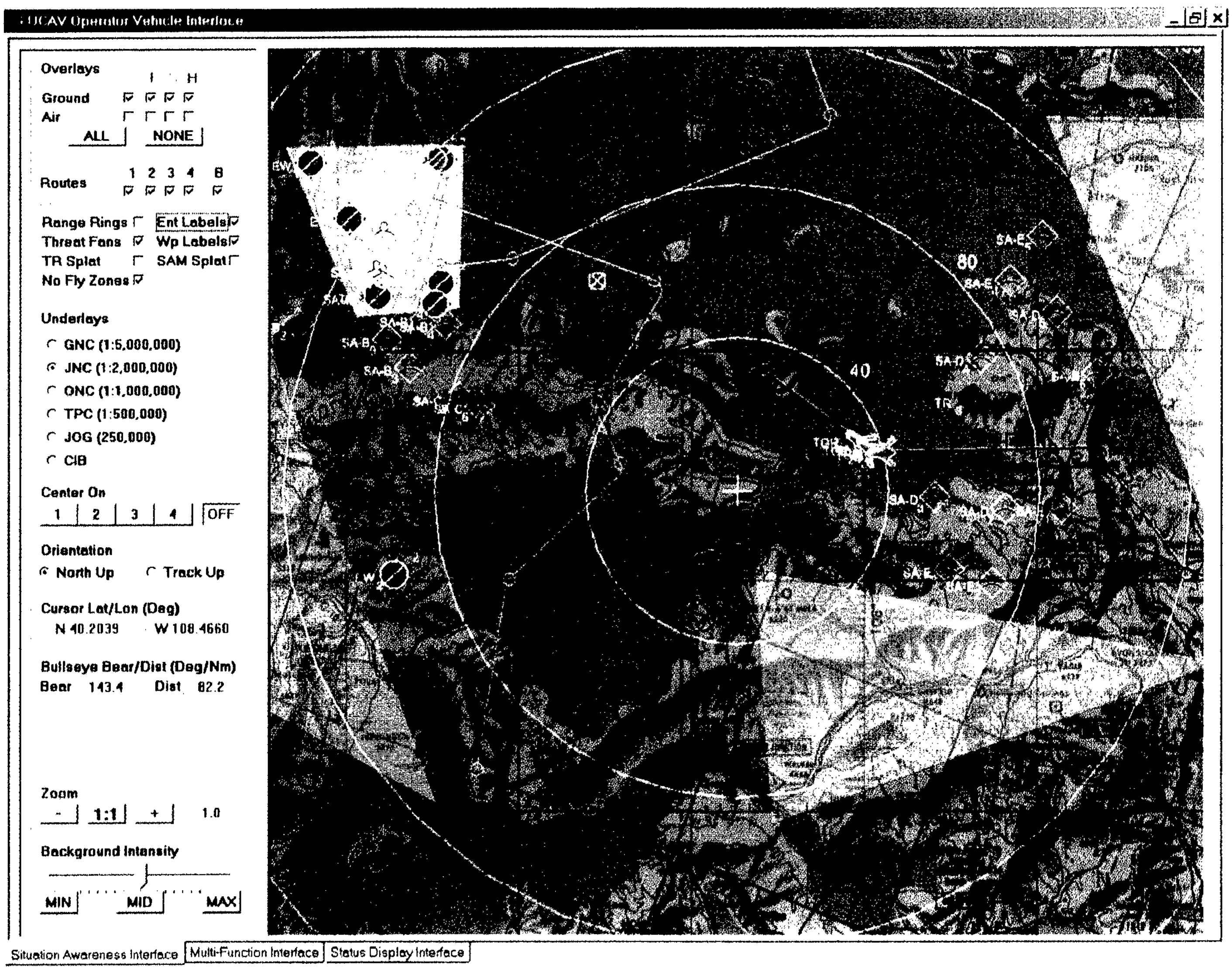


Figure 2. Situation Awareness display from the prototype control station.

The UCAV OVI program is performing analyses, design/redesign, and evaluation to develop a set of design guidelines for applying automation and human-computer interface (HCI) technologies. With a near-infinite number of design possibilities, we are using subject-matter experts—former Air Force pilots who have flown SEAD missions—to decompose the mission to develop a design requirement scenario (very similar to a concept of operations). This identifies functional and information requirements for the control station design. The requirements, analyses, and decompositions then serve as the basis for developing conceptual OVI designs and for evaluating their usefulness for multiple UCAV control within the SEAD context.

Our first prototype OVI control station (Figure 1, page 1) consisted of three 20-inch (diagonal measurement) liquid crystal displays (LCDs) placed side-by-side in a wrap-around console, occupying about 100 degrees of the operator's field-of-view. During the evaluation, a computer mouse and keyboard comprised the primary input devices; however, a voice recognition interface was also demonstrated to the participants after the formal data sessions for subjective impressions and critique.

The initial prototype control station had three displays called Situation Awareness (SA), UCAV Status, and Multifunction. The SA display, on the left of Figure 1 (see Figure 2), was a dynamic, large-scale presentation of the combat area with all relevant friendly and hostile players overlaid on a navigation map depicting relevant terrain and cultural features. Overlaid were the UCAV's locations and flight routes, other strike aircraft and their flight routes, combat area threats, and the targets. The operator had data filtering, zoom, and pan capabilities.

The UCAV Status display, on the right of Figure 1, provided health and status of the four UCAVs: a pictorial indication of selected flight parameters, flight performance, system malfunctions, weapon inventory and status, data link status, and radar warnings. Used primarily as a system monitor, the operator could query this display for detailed information on malfunctions, reset subsystems, and manually adjust certain flight parameters.

In the center is the Multifunction display for managing most of the mission events. A multifunction control panel on the right side of the display was used to select navigation, weapons, or communications modes as well as to set specific parameters for each. A map control panel on the left side of the display was used for map zooming, scaling, and map features selections, thus duplicating some of the capabilities of the SA format. Dedicated "windows" within the multifunction control panels showed master warnings, cautions, and advisories for system malfunctions and pop-up threats.

Nine subjects, acting as UCAV operators, used the control station to manage a flight of four UCAVs within a part-task (ingress and attack) SEAD mission. Each operator monitored the progress of the pre-planned mission, adjusted the UCAVs' routes to avoid unanticipated threats, monitored changes in the threat environment, adjusted target assignments in response to those changes, and released weapons at the proper time. In half of the evaluation conditions, the operator manually accomplished several route replanning and target assignment tasks. In the other half (semi-automatic), the operator used simulated decision aids to accomplish these tasks by assessing the decision-aid recommendations, and selecting one solution from among the several produced. To determine how stress would affect performance, sometimes operators were allowed less than two minutes to update the route plan or reassign targets; at other times they were allowed as much as five minutes.

Each four-hour session included a training briefing, hands-on control station training, and eight data collection runs (two mission segments; two time stress levels; manual and semi-automatic tasking), familiarization with the voice recognition interface, and a period of time dedicated to a detailed experiment debriefing. The Subjective Workload Assessment Technique (SWAT) was used to estimate workload and to identify tasks where excessive operator workload existed. Questionnaires and interviews were used to collect operator narrative comments and subjective ratings for situation awareness and interface usability.

Comparing the manual versus semi-automatic route replanning, we found that more work is needed on the replanner interface. In real combat, data received may be inaccurate or untimely, and the automated planner may generate non-optimum routes. The decision-aiding system should help the operator trouble-shoot the data and solutions.

Several participants felt the SEAD mission scenario was overly simplistic, and that the greater complexity of a real battle would require UCAV capabilities that are broad, and yet flexibly controlled. The UCAV operator needs a wide range of tactics or countermeasures to avoid, suppress, or destroy enemy defenses.

continued from previous page

For further information about the UCAV Operator Vehicle Interface (OVI) program, contact:

Mr. Greg Feitshans
AFRL/HECI
2210 Eighth Street, Suite 11
WPAFB, OH 45433-7521

Tel: 937-255-8278
E-mail: gregory.feitshans@wpafb.af.mil

Mr. Greg Barbato is an Engineering Psychologist in the U.S. Air Force Research Laboratory, Human Effectiveness Directorate, Crew-System Interface Division, Wright Patterson AFB, OH. He is currently the Human Systems Integration focal point on the Mission Control Station IPT for the AF/DARPA UCAV Advanced Technology Development program.

On the issue of how many UCAVs a single operator could manage, we found that four was not a problem as long as the original plan unfolded as expected with little or no variation. However, when a number of unexpected events occur, managing four UCAVs simultaneously will require better automation in the operator's station.

Debriefings indicated that the OVI provided adequate situation awareness when there were limited external events and no system malfunctions in the scenario. Subjects with operational experience made greater use of the status display because their training and combat experience dictated that "if something isn't happening now, it's only a matter of time before it does." They judged all the display formats as "must haves." There were numerous instances where participants without operational experience fixated on the center Multifunction display, degrading performance for reroute and weapon assignment tasks.

The operators found the automated target assignment function to be effective and necessary to reduce the higher workload associated with manual assignment, which usually took excessive time and often resulted in situations where the UCAVs had passed the preprogrammed launch point. This is significant because the scenario was not as complex as many real-world cases.

Where the operator did complete manual target reassignment, there were numerous instances where intended targets were not designated, unintended targets were designated, and the numbers of weapons per target were not as planned. Issues of degraded modes of operation and multiple weapon loads were entirely too complex to include in this experiment. It is clear that, while additional automation will be necessary, further manual/automatic tradeoff assessments will be needed. ■

address needed!

If your address label does NOT include a complete street address, PO Box, or ZIP code, please provide us with this information. We are trying to comply with the regulations of the U.S. Postal Service. Without this information we cannot guarantee your continued receipt of CSERIAC **GATEWAY**. Please E-mail changes to: **jeff.landis@wpafb.af.mil** or mail changes to:

CSERIAC **GATEWAY**
AFRL/HEC/CSERIAC BLDG 196
2261 MONAHAN WAY
WPAFB OH 45433-7022

IAC Awareness Conference

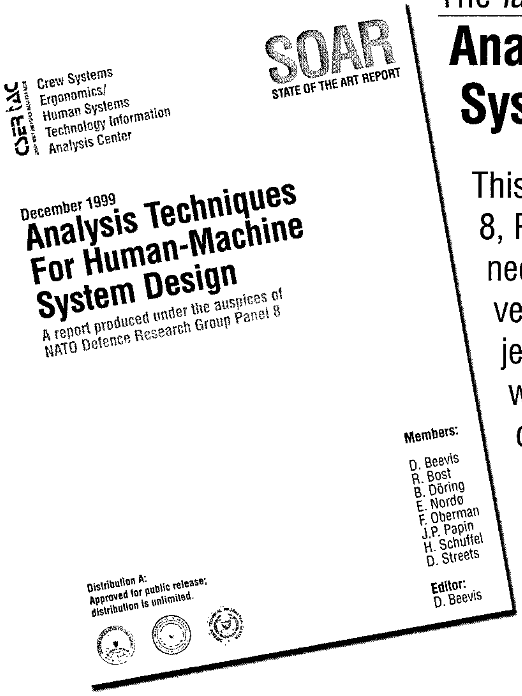
The Defense Technical Information Center (DTIC) Information Analysis Center (IAC) Program Management Office will sponsor an IAC Awareness Conference on May 16, 2000 at the Hope Hotel, Wright-Patterson Air Force Base, Dayton, Ohio. The theme of this conference is "Key Challenges" that need to be conquered to enable us to meet Joint Vision 2010. The meeting is open to all Department of Defense (DoD) and associated industry personnel. This meeting will promote IAC awareness with an emphasis on the needs of the warfighter.

The objective of this conference is to explore the strategic direction and the resulting requirements of information technology and services necessary to support the DoD. To that end, an aggressive agenda with senior-level participants will provide an opportunity to discuss and share valuable insights between research and development and the warfighter community.

Those in attendance will include policy makers, DoD program managers, researchers, analysts, information providers, and information users. This conference will address the information needs of the warfighter, along with the current and future information technology initiatives to support those needs in the new millennium. The impact of changes in the policies, procedures, and technologies of information now and in the future and the subsequent impact on DoD will also be addressed.

DoD IACs will have exhibits in the display area highlighting their capabilities, products, and services.

Electronic registration is encouraged via the SURVIAC Web site at http://iac.dtic.mil/surviac. Additional registration information may be obtained from Ms. Donna Egner, SURVIAC, by telephone: 937-255-4840, fax: 937-255-9673, or E-mail: degner@bah.com.



The *latest* CSERIAC state-of-the-art report (SOAR)

Analysis Techniques for Human-Machine Systems Design

This SOAR is based on the work of NATO Defence Research Group, Panel 8, Research Study Group 14, to improve the application of human engineering techniques in NATO countries. Research Study Group 14 surveyed the use of 24 human engineering analysis techniques in 33 projects in 7 countries. This SOAR presents the results of this survey which includes a wide variety of military systems: an infantry air defense system, tanks, aircraft, ships, submarines, and command and control systems.

Available for 45^{00} (US) plus shipping and handling. To order, telephone: 937-255-4842, fax: 937-255-4823, or E-mail: michelle.dahle@wpafb.af.mil.

http://iac.dtic.mil/cseriac

The Director's Desk

Tom Metzler

Figure 1. New CSERIAC Director Tom Metzler

I would like to introduce myself as the new Director for CSERIAC (see Figure 1) and provide you with the perspective that I have gained over thirty years of working in the U.S. Department of Defense human factors and crew systems field. I have enjoyed the opportunity to work on many aviation weapon systems. In 1968, I was assigned to the C-5A System Program Office at Wright-Patterson Air Force Base, just after the C-5A's first flight, and worked through many of the human factors issues in that program. At that time, Personnel Subsystems was the name given our area of focus and as I gained experience in this and subsequent efforts, like the initial flight testing of the F-15, A-10, F-16/17 competition, YC-14/15 competition and later with the Army on the UH-60, AH-64, OH-58D, CH-47D, the same issues kept surfacing. These issues were all centered on the integration aspects of the system with the human.

Our objective has always been to effectively integrate the system and the human without making compromises that would limit the performance of the mission; reduce safety or survivability; increase training cost and manpower burden; or present a health hazard. Each of these issues would reappear and the human factors community seemed more than willing to point out the shortcomings or deficiencies in these systems. However, we did not have the knowledge to effectively employ analysis methods, models, and simulation tools or apply them early enough in the design process to always result in an effectively integrated system.

To become more proactive, I attended the Defense Systems Management College Program Managers Course, believing that if I understood some of the program management requirements and gained that perspective, then potentially I could help make a difference in the acquisition process. This way, I could help the human-system interface issues to be better addressed, and avoid the costly and ineffective "work around."

Having had the experience as a Program Manager for the Army Aviation Program Executive Office, I believe that a key element to the effective interface is having the right information at the right time so that smart decisions can be made early during the acquisition process. Often the time of greatest importance is before the contract is awarded, when requirements and system performance objectives are determined.

In addition, having worked my last assignment with the Naval Aviation Crew Systems Department, I saw the benefits to be gained by building effective roadmaps that addressed the transition of human-system product information from the science and technology community to the acquisition communi-

ty. Therein lies CSERIAC's mission: supporting all the services in transferring the information products from the researcher through the developer to the end user. The focus must be on producing human-systems integrated weapon systems so that we bridge the gap from the science and technology database to the development and system acquisition community (government and contractor). The design, development, testing, fielding, and support of systems must be accomplished with the benefit of the best science and technology information available that pertains to human-systems integration.

With the expanded role that human-system integration brings, I do not believe that our mission really has changed that much in the past 30 years. The soldier, sailor, airman, maintainer, gunner, and pilot will only be as effective in achieving the warfighter mission as we can effectively address the interface/integration issues. If we are unable to accomplish this up front, then costly fixes will be proposed, most of which will not be affordable, and the weapon system will continue to be less effective at doing what it was built to accomplish. My objective is to join with you, and as a team, to do whatever we can to support the service member who is in the field by providing the right information to the right people when it can be used to make a difference.

Please call me personally at 937-255-6623 or E-mail me at tom.metzler @wpafb.af.mil if you have any human-systems integration issues for which you need the right information to make a difference.

On another note, in the near future CSERIAC will be changing its name to the "Human Systems IAC" in an effort to better address the total systems approach regarding the integration of the human with today's weapons systems. This change is consistent with the domains of Human-Systems Integration identified in DoD Policy (DoD Directive 5000.1, Section D.1.e).

Tom Metzler is the Director for CSERIAC.

apr

The Hague, The Netherlands. April 1-6, 2000
CHI 2000 Conference on Human Factors in Computing Systems
Contact CHI 2000 Office, 703 Giddings Avenue, Suite U-3, Annapolis, MD 21401, USA.
Tel: +1-410-263-5382, Fax: +1-410-267-0332, E-mail: CHI2000-office@acm.org,
URL: http://www.acm.org/sigchi/chi2000/

Yellow Springs, OH, USA. April 25-27, 2000
Essentials of Anthropometry
Contact Anthrotech (formerly Anthropology Research Project, Inc.), 503 Xenia Avenue, Yellow Springs, OH 45387, USA. Tel: +1-937-767-7226, Fax: +1-937-767-9350, E-mail: belva@anthrotech.net, URL: http://www.anthrotech.net

may

Washington, DC, USA. May 1-4, 2000
44th Biennial Meeting of the U.S. Department of Defense Human Factors Engineering Technical Advisory Group
Contact Sheryl Cosing, 10822 Crippen Vale Court, Reston, VA 20194, USA.
Tel: +1-703-925-9791, Fax: +1-703-925-9644, E-mail: sherylynn@aol.com,
URL: http://dticam.dtic.mil/hftag/hftag.html. *Meeting is open to all government personnel and others by specific invitation.*

Dayton, OH, USA. May 16, 2000
IAC Awareness Conference
Contact SURVIAC, AFRL/VA/SURVIAC Bldg 45, 2130 8th Street, Wright-Patterson AFB, OH 45433-7542, USA. Tel: +1-937-255-4840, Fax: +1-937-255-9673, E-mail: degner@bah.com, URL: http://iac.dtic.mil/surviac

jun

San Jose, CA, USA. June 5-7, 2000
Silicon Valley Ergonomics Conference & Exposition
Contact Abbas Moallem, Ph.D., ErgoCon 2000, San Jose State University, One Washington Square, San Jose, CA 95192-0180, USA. Tel: +1-408-924-4132, Fax: +1-408-924-4040, URL: http://www.engr.sjsu.edu/ergocon

Dearborn, MI, USA. June 6-8, 2000
Digital Human Modeling for Design and Engineering Conference and Exposition
Contact: Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096-0001, USA. Tel: +1-724-776-4841, Fax: +1-724-772-1851, URL: http://www.sae.org

Ann Arbor, MI, USA. June 12-16, 2000
Occupational Ergonomics Course
Contact Center for Professional Development, University of Michigan College of Engineering, 2121 Bonisteel Boulevard, Ann Arbor, Michigan 48109-2092, USA.
Tel: +1-734-647-7200, Fax: +1-734-647-7182.

Ann Arbor, MI, USA. June 19-21, 2000
Job Analysis and Field Studies Course
Contact Center for Professional Development, University of Michigan College of Engineering, 2121 Bonisteel Boulevard, Ann Arbor, Michigan 48109-2092, USA. Tel: +1-734-647-7200, Fax: +1-734-647-7182.

Virginia Beach, VA, USA. June 20-22, 2000
Threats, Countermeasures, & Situational Awareness: Teaming for Survivability Symposium & Exhibition
Contact Tom Assenmacher, Naval Air Warfare Center Aircraft Division, Human Engineering Applications Branch (4.6.4.2), Building 2187, Suite 2280, 48110 Shaw Road, Unit 5, Patuxent River, MD 20670-1906, USA. Tel: +1-301-342-0026, DSN: 342-0026, Fax: +1-301-342-9305, E-mail: AssenmacheTJ@navair.navy.mil

aug

San Diego, CA, USA. July 30-August 4, 2000
IEA-2000/HFES-2000. International Ergonomics Association & Human Factors & Ergonomics Society Annual Meetings.
Contact HFES, PO Box 1369, Santa Monica, CA 90406-1369, USA.
Tel: +1-310-394-1811, Fax: +1-310-394-2410, E-mail: hfes@compuserve.com,
URLs: http://iea2000.hfes.org *and* http://hfes.org

sep

Crieff, Scotland. September 4-8, 2000
The 24th Conference of the European Association for Aviation Psychology (EAAP)
Contact Dr. Malcolm James Cook, University of Abertay, 158 Marketgait, Dundee, Scotland DD1 1NJ. Tel: +44-1382-308178, Fax: +44-1382-223121;
E-mail: mcook@abertay.ac.uk, URL: http://www.eaap.com

Toulouse, France. September 27-29, 2000
International Conference on Human-Computer Interaction in Aeronautics, HCI-Aero 2000
Contact Ms. Helen Wilson, HCI-Aero 2000 Office, European Institute of Cognitive Sciences and Engineering (EURISCO), 4 Avenue Edouard Belin, 31400 Toulouse, France. Tel: +33-5-62-17-38-38, Fax: +33-5-62-17-38-39, E-mail: wilson@onecert.fr,
URL: http://www-eurisco.onecert.fr/

oct

Edinburgh, Scotland. Oct 25-27, 2000
Third International Conference on Engineering Psychology and Cognitive Ergonomics
Contact Dr. Don Harris, Human Factors Group, College of Aeronautics, Cranfield University, Cranfield, Bedford MK43 0AL, UK. Tel: +44-1234-750111 ext. 5196, Fax: +44-1234-750192,
E-mail: icep@cranfield.ac.uk, URL: http://www.cranfield.ac.uk/coa/coa_conf.htm

Human Systems Integration Technologies, Tools, and Techniques (HSIT³)

Rebecca Singer

Editor's note: Rebecca Singer, a Human Factors Analyst at CSERIAC, has written a guest column at the request of Dr. Fineberg for this issue of Gateway. *Dr. Fineberg's regular column will return in the next issue.*

The success of any system depends on the consideration of numerous, carefully integrated issues; unfortunately, many of these issues are often overlooked in the system development process. Designers not only need to consider the engineering aspects of design, but also the environment in which the system will be used, who will be using the system, how much training is involved, and the health and safety aspects of the user. For complete success, these issues must be considered and implemented throughout the entire process, from the acquisition and procurement stage to delivery. These issues are all part of the MANpower and PeRsonnel INTegration (MANPRINT) program, which the U.S. Army implemented in the 1980s to ensure that soldier and unit needs are considered throughout the acquisition and life cycle of a system.

However, some problems have developed over the years that impeded the wider addition of this level of Human-Systems Integration (HSI), not only with the Army's MANPRINT program, but also those programs modeling MANPRINT (e.g., Canada's Human-Systems Integration program and the United Kingdom's Human-Factors Integration program). Due to limited guidelines and material that describe the methodologies, attempts to achieve cost and performance benefits similar to those in the past have been difficult. For example, there are:

- Limited formal descriptions of several HSI domains
- No metrics for return on investment from HSI Research and Development (R&D)
- No detailed descriptions for applying HSI methods under acquisition reform
- Inadequate educational materials on HSI for practitioners
- No formal knowledge of the current state of the art in HSI
- No general understanding of the current voids in HSI data and methodologies

Although much has been accomplished since MANPRINT was introduced 14 years ago, there remains tremendous potential for the application of HSI in future systems. As a result, a major effort has been undertaken to capture the theoretical advances and lessons learned in the development and applications of HSI technologies, tools, and techniques. The domain of HSI is depicted in Table 1.

Under the sponsorship of the U.S. Army Research Laboratory, Human Research and Engineering Directorate, with the support of the U.S. Air Force Research Laboratory, Human Effectiveness Directorate, and numerous other government agencies, CSERIAC has taken a user-oriented approach to conduct a complete state-of-the-art study on HSI. This approach comprises three major goals:

- A user survey
- A workshop and a seminar, and
- A Human-Systems Integration state-of-the-art report (SOAR), the SOAR resulting from the survey, workshops, and seminar.

In keeping with the fundamental tenet of human factors philosophy—when in doubt, ask the user—the first step in this task was to conduct a user survey to identify the requirements of potential users as well as possible SOAR chapter titles and potential authors. The survey was sent to HSI subject-matter experts and MANPRINT practitioners throughout government, academia, and industry. By polling the user community it was possible to determine the voids in the methodologies (quantifying "return on investment" for MANPRINT fixes, no requirement for

Table 1. Human-Systems Integration Domain

Manpower—The number of military and civilian personnel required and potentially available to operate, maintain, sustain, and provide training for systems.
Personnel—The cognitive and physical capabilities required to be able to train for, operate, maintain, and sustain materiel and information systems.
Training—The instruction or education, and on-the-job or unit training required to provide personnel their essential job skills, knowledge, and attitudes.
Human Factors Engineering—The integration of human characteristics into system definition, design, development, and evaluation to optimize the performance of human-machine performance under operational conditions.
System Safety—The design features and operating characteristics of a system that serve to minimize the potential for human or machine errors or failure that can cause injurious accidents.
Health Hazards—The design features and operating characteristics of a system that create significant risks of bodily injury or death; prominent sources of health hazards include acoustics energy, chemical substances, biological substances, temperature extremes, radiation energy, oxygen deficiency, shock (non-electrical), trauma, and vibration.
Soldier Survivability—The characteristics of a system that can reduce fratricide, detectability and probability of being attacked, as well as minimize system damage, soldier injury, and cognitive and physical fatigue.

Table reprinted from the U.S. Army MANPRINT Program website, http://www.manprint.army.mil/

mandatory implementation); the obstacles to implementing the MANPRINT approach (funding resources, lack of reliable test data); and finally, the needs for successful HSI implementation in system design (better understanding of HSI implications, and top-level leadership support for implementation).

The second step of this task was to conduct a workshop to investigate the implications of HSI technology and advancements, and to further narrow the scope of the SOAR. This workshop was held on January 19–20, 2000 in Arlington, Virginia with representatives from the Army, Air Force, Navy, FAA, NASA, United Kingdom Ministry of Defence, and industry. The results of the user survey were used as a basis for defining the focus of the two-day event. Participants were tasked to provide input and review chapter proposals in an effort to determine the content of the SOAR and identify chapter authors. They were also asked to recommend contributors to an upcoming seminar on HSI Technologies, Tools, and Techniques, scheduled for June 15–16, 2000.

The HSIT³ Seminar will be held to showcase the advancements in human factors engineering technologies, tools, and techniques used to implement MANPRINT/Human-Systems Integration in government and industry. Participation is expected to be even wider than the January workshop, with representatives from all DoD services, other U.S. agencies, industry, academia, and other countries being invited to this event.

The third and final step in this approach will be the HSI state-of-the-art report. This report, which is in the preliminary stages, will document the principles and methods of HSI including, for example, the HSI methods and technologies of the seven domains of HSI, HSI in the acquisition process, and examples of HSI applications to military and commercial systems. Although a wide readership is expected, first and foremost is the HSI professional. By first polling the HSI and MANPRINT practitioners as to their requirements for HSI information, and then conducting a workshop with HSI professionals, we hope to ensure that the resulting product will serve as a practical resource to the community. This is particularly important at a time when HSI is even more critical to the success of our forces in combat. ■

For further information, please contact Rebecca Singer at:

Tel: 937-255-6484
Fax: 937-255-4823
E-mail: rebecca.singer@wpafb.af.mil

Designing for Extra-ordinary People and Situations

Alan Newell & Peter Gregor

Figure 1. The human interface challenges within high-performance aircraft have many similarities to those of facilitating a disabled person to perform less demanding tasks such as word processing.

To build better interfaces, it is important to realize the diversity of the human population. Including people with obvious disabilities is good design practice, and there are a number of parallels between human-computer interaction (HCI) for disabled and non-disabled people. The research agenda in the Applied Computing Department at Dundee University has illuminated this fertile field of interdisciplinary collaboration. The Department contains one of the largest and most influential academic groups in the world researching communication systems for disabled people, and has strong international and national reputations in other aspects of HCI research. As part of this research, the Department developed the concept of Ordinary and Extra-ordinary HCI. That is, extra-ordinary (disabled) people operating in ordinary environments pose similar problems to able-bodied (ordinary) people operating in extra-ordinary (high workload, environmentally unfriendly) situations.

In his keynote address to InterCHI '93, Newell underlined the importance of research and development in HCI taking into account the full diversity of the potential user population (Newell, 1993, 1995; Newell & Cairns,1993). He pointed to the cassette tape recorder, initially produced in England for talking-books for the blind, as the most ubiquitous example of design for disability producing better design for everyone. Techniques that are being used in mobile phones to allow orthographic text to be entered by a ten-key keyboard were developed many years previously by rehabilitation engineers specifically for people with poor hand skills. Predictive and adaptive interfaces were developed for people with disabilities in the early 1970s, and a major user group for speech synthesis and speech recognition systems over many years has been disabled people.

Disabled people, however, are not a homogenous group, and although one can be considered as a "person with disabilities," this is only a small part of the population of people who have reduced functionality. A large percentage of the population have some functionality which is significantly less than the norm, and most people go through phases where they are temporarily disabled either by accident, alcohol, drugs, stress, or even fatigue.

People can also be handicapped by their environment. An extreme example of this is a soldier on a battlefield who may be blinded by gun smoke, deafened by gunfire, mobility-impaired because of the terrain, dextrously impaired because of protective clothing, and cognitively impaired due to high stress. In addition, of course, soldiers have a higher likelihood of being wounded than computer operators, which can reduce their functionality even more! Thus in HCI terms, a soldier is an example of a very handicapped person.

This also applies to pilots of high-performance aircraft. A person in a high-workload environment,

and a disabled person trying to do an ordinary job, can both be constrained by the low bandwidth between the operator and the computer. The pilot of a high-performance aircraft may not be able to see and hear enough information, nor be able to move the controls as fast as necessary to fly his or her aircraft really well (see Figure 1). This is the same problem faced by an impaired person who may find it difficult to see enough of his word-processor file or be unable to operate the keys fast enough to do an effective and efficient job (see Figure 2).

Examining the extremes of HCI, such as with users with disabilities, can tell us a great deal about HCI generally, and informing designers that some of their users may be disabled encourages user-centered design because the designers know that the users may be very dissimilar to themselves. Also, interpersonal communication via technology effectively handicaps the user. Video conferencing provides sensory input not unlike tunnel vision and hearing impairment, and E-mail makes no use of the speech or hearing capabilities of the users. An understanding of the communication problems of those with visual, speech, and hearing dysfunction may thus give designers useful clues about how to improve the use of such technologies, and what extra functionality is needed in the interface to cope with the technologically induced dysfunction in the users.

The philosophy outlined above has led to a number of collaborative projects in Dundee with industrial partners. These include "ARCHIE," a European-funded project, conducted in collaboration with Computer Resources International (Denmark), GEC-Marconi Avionics (UK), Bertin & CIE (France), Sofreavia (France), and the UK Civil Aviation Authority. The Dundee group developed the idea of a multi-modal interaction and intention-inferencing system, which was applied to systems designed for a disabled secretary, the pilot of a high-performance aircraft, and an air-traffic control system by the respective partners in the consortium. A current project follows a similar philosophy, where Dundee is utilizing its expertise in systems for people with disabilities to develop head-up and gesture-driven displays for automobile dashboards.

This concept of ordinary and extra-ordinary HCI is a powerful design aid, and is highly recommended for all user-centered designers and crew system designers in particular. ■

References

Newell, A.F. (1993, Sep). Interfaces for the ordinary and beyond. *IEEE Software, 10*(5), pp. 76-78

Newell, A.F. (1995). Extra-ordinary Human Computer Operation. In A.D.N. Edwards (Ed.), *Extra-ordinary Human-Computer Interactions*. Cambridge, United Kingdom: Cambridge University Press.

Newell, A.F. & Cairns, A.Y. (1993, Oct). Designing for extra-ordinary users. *Ergonomics in Design*, pp. 10-16

Figure 2. Devices that allow a disabled person to operate the keys on a word-processor decrease his or her efficiency much like the environment of a sophisticated aircraft decreases the efficiency of an able-bodied pilot.

For further information, please contact:

Prof. Alan F. Newell
Department of Applied Computing
University of Dundee
Dundee DD1 4HN
Scotland

Tel: +44-1382-344145
Fax: +44-1382-345509
E-mail: afn@computing.dundee.ac.uk
URL: http://www.computing.dundee.ac.uk

Professor Alan Newell, Ph.D., FRSE, is Head of the Department of Applied Computing, University of Dundee, Scotland. Peter Gregor, Ph.D., is a lecturer in the Department of Applied Computing, University of Dundee.

Leveraging the Technical Area Task (TAT) Program

Tom Metzler

Table 1. CSERIAC's Domain

- Human Factors Engineering
- Health Hazards
- Safety Factors
- Personnel Survivability Factors
- Manpower, Personnel, and Training
- Medical Factors
- Automation and Human-Machine Integration
- Display and Control Design
- Environmental Issues
- Equipment and Vehicle Design
- Human Characteristics
- Human-Computer Interfaces
- Information Presentation and Communication
- Methods for Research, Testing, and Evaluation
- Performance-Related Factors
- System Perspectives
- Work Design and Organization
- Workstation and Facility Design

One of the objectives of the U.S. Department of Defense (DoD) Information Analysis Center (IAC) Program is to maintain technical centers of excellence that can be called upon to facilitate use of existing scientific and technical information (STI) to meet DoD research, acquisition, operational, and logistics requirements. As a DoD institution, CSERIAC provides the foundation through which data gathering, studies, analyses, and other scientific and technical activities can be accomplished.

CSERIAC's area of expertise is human factors and ergonomics, an integrative discipline devoted to understanding and quantifying human interaction with equipment and systems. It encompasses a broad scope of issues important to the design of safe, effective, user-friendly, and maintenance-friendly systems. The domains within CSERIAC's purview are listed in Table 1.

IAC operations include core functions and technical area task (TAT) activities. Core functions comprise basic services such as the collection of STI, inquiry support, database operations, current awareness activities (e.g., the *CSERIAC Gateway* newsletter), and the generation of state-of-the-art-reports (SOARs). TATs fall within the scope of the IAC mission, but are not funded as a part of the IAC's basic services. Typically technical and analytical in nature, TATs are more labor intensive and complex, and may involve extensive gathering or creation of STI, analysis, and preparation and dissemination of information.

One TAT currently being performed by CSERIAC is the Controller-Pilot Data-Link Communication (CPDLC) TAT. Realizing that the current Federal Aviation Administration (FAA) voice-traffic communication system is deficient in many ways, the FAA requested information for use in developing cockpit data-link studies, and for use in updating FAA Advisory Circulars related to flight-deck systems. Using human-in-the-loop simulation, CSERIAC helped the FAA evaluate alternative designs for large-scale distributed simulations of data-link communication systems.

Another TAT being performed by CSERIAC is updating the U.S. Army MANpower and PeRsonnel INTegration (MANPRINT) Program as a Human-Systems Integration Program. The U.S. Army Research Laboratory's Human Research and Engineering Directorate and several other DoD components are the primary sponsors of this project. Within this effort, CSERIAC has conducted a user survey and workshop, and will conduct a seminar, all of which will lead to the publication of a state-of-the-art report on this important topic. Rebecca Singer, a CSERIAC Human Factors Analyst leading the effort on this TAT, has written an article detailing the program in this issue of *Gateway* on page 10.

CSERIAC helps customers refine their requirements for research and analysis products and provides fast, effortless contracting. In addition, products are entered into the CSERIAC collection, thus contributing to the growth of the human factors engineering knowledge-base. Other DoD organizations can access the STI developed through the TAT and leverage prior research and analyses to support their requirements. Releasability of TAT products is coordinated with the originating organization to ensure compliance with secondary distribution instructions. For more information on available products generated through the TAT program, contact CSERIAC via telephone: 937-255-4842, fax: 937-255-4823, or E-mail: tom.metzler@wpafb.af.mil.

Tom Metzler is the Director of CSERIAC.

Special Issue on: Aviation Psychology

Papers are invited for a special issue of the *International Journal of Aviation Psychology*, focusing on training instructors to evaluate aircrew performance. Papers that will further the understanding of how instructors and evaluators can be most effectively trained to evaluate crew performance are welcome. Submissions are due April 1, 2000. Contact David P. Baker, American Institutes for Research, 3333 K Street NW, Washington, DC 20007, USA. Tel: +1-202-342-5036, Fax: +1-202-342-5033, E-mail: dbaker@air.org.

Dear CSERIAC

To show the diversity of support that CSERIAC provides, the column below contains a sampling of some of the more interesting questions asked of CSERIAC. In response to these questions, CSERIAC conducts literature and reference searches, and, in some cases, consults with subject-area experts.

These questions were compiled by Michael Reynolds, Senior Human Factors Analyst. If you would like to comment on any of these questions or issues related to them, please write to "Dear CSERIAC" at the address found on the back cover of **GATEWAY**.

- A U.S. Air Force engineer requested data relating lifting to the possible number of push-ups in 2 minutes, the possible number of sit-ups in 2 minutes, and 2-mile run times.

- Information on common flat-panel displays for tracked vehicles in the U.S. Army was requested by a U.S. Government contractor.

- A U.S. Government contractor requested information on thermal contact hazards, specifically the maximum temperatures for various materials and contact durations.

- A U.S. Air Force engineer requested information on human visual characteristics related to depth perception just-noticeable-differences (JNDs); specifically, the engineer wanted to know at what difference in convergence angles is depth cued?

- U.S. Air Force occupational illness and injury types and rates were sought by a U.S. Air Force engineer.

- An engineer from a commercial aircraft manufacturer wanted to know the 3rd percentile female's ability to push with a thumb upward on a ¾-inch to 1-inch button located on the bottom of a horizontal surface 5 ft. above ground.

- Information on test and evaluation activities relevant to aircrew radios was requested by an engineer for a U.S. Government contractor.

- A U.S. Army engineer inquired about the availability of images from the CSERIAC-developed Global Positioning System (GPS) tutorial.

- A Canadian Air Force officer requested information about the CSERIAC-developed Global Positioning System (GPS) tutorial.

- A Federal Aviation Administration engineer requested information about training methods and the differences in self-paced versus instructor-paced learning rates.

ARMY NAVY AIR FORCE NASA FAA NATO

PROGRAM OFFICE
AFRL/HEC/CSERIAC BLDG 196
2261 MONAHAN WAY
WRIGHT-PATTERSON AFB OH 45433-7022

http://iac.dtic.mil/cseriac

(937) 255-4842 Telephone
(937) 785-4842 DSN
(937) 255-4823 Facsimile
(937) 255-2558 Gov. Tech Manager

DEPARTMENT OF THE AIR FORCE
OFFICIAL BUSINESS

Thomas Metzler, *Director*

Barbara Palmer, *Deputy Director*

Dr. Michael Fineberg, *Chief Scientist*

Dr. Joe McDaniel, *Gov. Technical Manager*

Tanya Ellifritt, *Assoc. Gov. Technical Manager*

Dr. Kenneth R. Boff, *Gov. Technical Director*

CSERIAC **GATEWAY** is published and distributed free of charge by the Crew System Ergonomics/Human Systems Technology Information Analysis Center (CSERIAC).

Jeffrey A. Landis, *Editor*
R. Anita Cochran, *Copy Editor*
Christina P. McNemar, *Art Director*
Ahnie Senft, *Graphic Artist*